

The effects of artificial intelligence on the Kenyan society

Rebeccah Ndungi, Maria Ulfah Siregar

Department of Informatics, Faculty of Science and Technology, UIN Sunan Kalijaga, Yogyakarta, Indonesia

Article Info

Article history:

Received Jan 15, 2022

Revised Jul 5, 2023

Accepted Aug 30, 2023

Keywords:

Human-like abilities

Impact of AI

Internet

Mimic

Technology

ABSTRACT

Artificial intelligence technology (AI) is an array of computer technologies that provide machines with human-like abilities in perception, action, and cognition. It can mimic human intellect in a broad variety of situations thanks to its advanced processing of information and mega-thinking procedures and powers. AI's power to mimic the intellect of humans means it will disrupt or significantly affect practically every major industry, including but not limited to manufacturing, healthcare, agriculture, and logistics. AI helps several industries move forward. Developed Western nations and leading digital titans like Google and Facebook have invested significantly in AI, utilizing its human skills in various vital societal sectors. Regrettably, most poor countries, particularly those in the sub-Saharan African region, do not have the necessary administration, learning, data reserves, and legislation to support the adoption and implementation of AI. Nevertheless, certain countries in sub-Saharan Africa, such as Kenya, have incorporated and used AI technologies in several key areas for the benefit of their inhabitants. This article explores how AI has affected Kenya and demonstrates how other sub-Saharan African countries might use AI-related technology to their full potential.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Rebeccah Ndungi

Department of Informatics, Faculty of Science and Technology, UIN Sunan Kalijaga

55281, Yogyakarta, Indonesia

Email: rebeccahndungi94@gmail.com

1. INTRODUCTION

Artificial intelligence (AI) refers to the technologies that allow machines to mimic human intellect and to behave with human capacities for decision-making, thought, and intention [1]. According to [2], AI is the use of interconnected digital systems to carry out human-type work. Example applications include the human senses, language translation, decision-making, and speech recognition. In contrast [3] describes it as the development of AI, or particularly sophisticated computer programs. AI is similar to using computers to explore cognitive capacities; however, AI is not restricted to methods that can be observed in the body. AI refers to the use of computers to accomplish previously impossible tasks, such as sensing, acting, and thinking and reasoning like a human being. Reasoning pertains to the systematic process of arriving at logical conclusions [4]. Robotics, data mining, machine learning, visual expert systems, and the processing of natural languages are only some of the processes and methods used by AI. AI's ability to learn from data or experience and evolve in response to new information improves these features [3]. AI, in other words, is capable of logical behavior, rational thought, or combined results or techniques with other to perform automated reasoning [1], [5]. In today's information-based world, AI is widely considered to be a game-changer among the latest wave of developing technology associated with the "4th Industrial Revolution", in addition to the internet of things, and big data [6]. The reason for this is that AI has the potential to revolutionize virtually every sector of the economy [7], from production to healthcare to transportation.

AI is currently considered a new technology that has not yet reached its full potential. Its groundbreaking innovations, however, are likely to have an impact on every nation. Since 2016, global expenditures in AI have climbed to around \$30 billion, with just 10% going toward AI acquisitions and the remaining 90% going into deployment and R&D of AI technologies [8]. AI is now a part of everyday life thanks to the efforts of governments in the West and tech companies like Baidu, Amazon, and Google, among others [8]. Amazon, for its logistics system, has created AI-based autonomous robots; Facebook, for its facial recognition software. Many sub-Saharan countries have yet to realize the potential of AI to improve human life by fostering sustainable development [8]. Infrastructure, administration, schooling, and information resources and policies are severely lacking in nearly every nation in sub-Saharan Africa, making it difficult for these nations to effectively apply AI. Despite these obstacles, certain countries in sub-Saharan Africa have effectively integrated and utilized AI across sectors to better the lives of their population, including Nigeria, Kenya, the Republic of South Africa, the nation of Ethiopia, and Ghana [9]. These nations have what is needed in terms of digital infrastructure, information assets, education, and legislation to facilitate the widespread use of AI. The foundations of AI rely on computer algorithms and data science to perform tasks like picture recognition, natural language analysis, and experiential learning. AI refers to the use of computational techniques for these purposes.

Currently, AI is being used in areas such as diagnosis in medicine, translation, autonomous vehicles, and risk assessment and management of investments in the financial sector. Machine learning usually requires little to no interaction with humans [10]. AI solves these areas' problems usually by breaking the problem solving process into subphases [11]. Additionally, a tiny dataset can be used to rapidly create a deep learning model with high-quality classifiers [10]. An eleven-person "Blockchain and AI Taskforce" has been assembled by Kenya's Ministry of Information, Communication, and Technology (ICT) to investigate how these technologies might be used for the country's development. The panel has a short period to present a fifteen-year plan that includes significant changes in 2027 and 2037 [12]. In order to examine the effects of AI technology and the possibilities it presents in sub-Saharan Africa; this article will use Kenya as a case study.

Kenya's government has made great strides in encouraging technological innovation over the past decade, thanks in large part to the country's increased focus on R&D and strengthened data protection legislation. The country's Ministry of Information, Communication, and Technology created a "Blockchain and AI Taskforce" to determine how these technologies can be applied to boost Kenya's economic development in 2018 [9]. The primary objectives aimed at improving public service delivery as a whole, a unified digital identity, financial accessibility, and democratic procedures. These measures demonstrate that the government of Kenya has established conducive policy conditions for AI-related adoption and development. In addition, a survey on AI-friendly legislation and regulations in sub-Saharan Africa found that Kenya has the most supportive regulatory environment.

The roles of AI in critical areas of Kenya's economy are as follows. The first is in teaching. Kenya's Ministry of Information, Communications, and Technology in 2018 reports that the country has implemented several cutting-edge projects to facilitate the delivery of individualized virtual classroom instruction using AI. Kenya introduced the AI-powered adaptive mobile educational management tool M-Shule in 2016 with the goal of improving primary school students' academic competency by analyzing their performance and providing lessons tailored to their needs via short message service (SMS) [12]. Every student's use of M-Shule is monitored and analyzed so that schools and parents can gain valuable insights and recommendations. The inherent risk of making mistakes in conventional classrooms is mitigated by M-Shule.

IMlango, an instructional technology initiative, was also launched in Kenya thanks to a collaboration between commercial and public institutions. To help teachers detect children who are chronically absent from school or class, IMlango employs cutting-edge analytics built on sQuid's digital record of attendance. IMlango also features a multimedia educational system that offers content in a variety of formats for both instructors and students to use [13]. If a student struggles in math, they can use a tool like Maths-Whizz (an adaptive virtual tutor) to get extra help and improve their math skills [1]. As a result of pinpointing and addressing the learner's specific areas of weakness, learning management systems help broaden students' access to higher education and boost their academic competence and performance.

Other area is in health sector. Significant structural difficulties in national healthcare systems exist in Kenya in most African countries, ranging from supply limitations to shortages of skilled healthcare practitioners [3]. The provision of high-quality healthcare to rural communities is hampered by a number of problems, including a lack of understanding of a range of health conditions, issues of accessibility, also real-time and unambiguous results [14]. By addressing both structural and accessibility issues, Kenya has deployed AI technology to close the healthcare gap and enhance outcomes. Several small businesses and major corporations have created AI-based medical products [3] to deal with these problems. For instance, Twitter and Messenger users can use the free intelligence chatbot Sophie Bot to ask questions about reproductive and sexual health services. This chatbot, created by a Kenyan company, aids in spreading information about and facilitating the availability of reproductive health services in a country where doing so is largely seen as taboo.

AI is being used to enhance Kenya's public health policy by enhancing healthcare delivery and access, empowering healthcare personnel, and supplementing their efforts.

Agriculture is the third area. Kenya relies heavily on agriculture, which produces the bulk of the country's GDP and provides the bulk of its workforce with jobs. Challenges to agriculture include climate change uncertainty, soil fertility decline, land degradation, new pest resistance, reliance on fertilizers that are inorganic, and difficulty gaining access to capital [3].

Kenya, however, has implemented a number of AI-powered solutions to address the aforementioned issues and boost productivity across the board in the agricultural sector. By offering a different credit scoring method for small-scale farmers, using machine learning, alternate data, and mobile phones, the Kenyan data analysis business created a mobile and web app to help creditworthy farmers gain access to financial institution loans [3]. Vital signs use the value or color of the pixel in satellite imagery to make estimates about rainfall and dry trends. Arifu provides farmers with tailored information, such as recommendations for the finest fertilizer, delivered by SMS [13]. Information on the farmer's land, location, and crops are used to determine the amount of credit FarmDrive can extend to buy necessary supplies like fertilizer [15], [16].

Conversational software, or "chatbots," the fourth area, are designed to mimic human conversation [17]. Chatbots help humans get more done in less time by answering questions automatically. Chatbots connect users to other individuals or other bots, in addition to giving information [18], [19]. Customer support chatbots are becoming increasingly commonplace. There is renewed curiosity in chatbots because of NLPs [19], [20]. Customers can type in questions and get clear responses in natural language because of chatbots' human-like dialogue [21]. Therefore, chatbots can process a large number of requests consisting of simple questions [21]. A chatbot will never get sick, tired, or grumpy. Therefore, [22], [23] suggest that listening and comprehending are the first steps in automating customer service. Chatbots have also found applications in other domains [21]. In the human resources sector, chatbots have lately been evaluated for use in the recruitment process [24]. Natural language processing has been greatly simplified by AI and machine learning, making complicated model chatbot systems much easier to learn and implement [25]. Another factor that has revitalized curiosity in chatbots is the widespread availability of chat apps. WhatsApp, Slack, Meta Facebook Messenger, and WeChat are just a few of the messaging apps that may help businesses connect with their customers [24], [26]. Several corporations in the IT sector are increasingly turning to chatbots as a form of virtual personal assistance [22], [23]. Online retailers, logistics firms, and even the New York Times utilize chatbots nowadays. The use of chatbots in advertising and customer service has increased in recent years [24], [26]. According to [27], by 2025, AI will be in charge of 95% of all consumer support interactions.

Theorists say that user adoption of chatbots has been slower than predicted [28], [29] despite the initial excitement surrounding their releases on Facebook and Microsoft. The immense potential of chatbots has not been completely realized by the IT industry. Many modern chatbots fall short of consumers' expectations for a variety of reasons, including nonsensical responses, ambiguous goals, and poor usability [30]. The developers do not appear to care about the end-user experience.

The fifth area is in digital assistants. The UBA Kenya Leo, Safaricom's Zuri, and the Jubilee Insurance Julie brands have all become well-known in Kenya. Online transactions, requests for service, and sales are all managed by these programs [31], [32]. Lack of education about the potential advantages brought by AI Chatbot software hinders its widespread adoption. The modern consumer values experience over material possessions. AI chatbots have the potential to aid businesses in providing individualized encounters by making conversations more meaningful, topical, and interactive. Additionally, several Kenyan farmers use Arifu Chatbot apps to learn about agronomic methods and finances. SMS-based dissemination of reputable agricultural information sources and related institutional resources to farmers at no cost [33]–[35]. Examples of currently developed Chatbot apps include Bot Analyst, Insurance Bot, Corporate Registration Bot, Book Division Bot, Approval Labor Bot, and Attendance Monitoring Bot [36], [37].

You can use them to keep track of your schedule, do more precise web searches, and issue commands to other programs. Using AI, apps may learn from each individual user's actions and interactions [38], [39]. Borrowers with little to no credit can get a loan evaluation and funding through the Tala mobile app. It can aid in tasks like calendar surveillance, search engine optimization, and application command implementation. The functionality of AI allows apps to learn from every user and their behavior [38], [39]. Through their mobile app, Tala screens loan applicants with little to no credit history and disburses funds [20], [21], [36]. The program allows the company to evaluate these previously ineligible clients by calculating their default risk based on Meta and S-M-S facts [12], [15]–[19], [22], [25], [39], [40].

The last area is on the integrity of audit data and moral judgement. In order to perform a review of an announcement of financial condition, auditors rely heavily on the audit report. It assures those performing audits that the numbers they're looking at are correct. In [41], [42] emphasized the importance of building efficient and workable controls over the use of AI to achieve ethical outcomes. However [43], [44] argued for the usefulness of AI in auditing, citing the necessity of establishing auditors' knowledge and skills through appropriate measures, as well as evaluating their ethical conduct, before any auditing decisions can be considered scientifically sound [45], [46].

2. METHOD

2.1. Location of the study

Kenya, Nigeria, Ghana, Ethiopia, and South Africa are just a few examples of countries in Africa that have made widespread use of AI. The majority of current solutions [41], [47] are geared toward the banking, farming, and medical sectors. Mixed-method research on the impact of AI across Africa found that the region was most heavily impacted in Kenya. Kenya, also known as the nation of Kenya and in Swahili as Jamhuri ya Kenya, is located in East Africa. Kenya has an area of 580,367 square kilometres, ranking it the 48th largest country in the world. The total number of people living there is close to 47.6 million [48] making it the 29th most populous country overall [49].

2.2. Target population

People from whom information is collected and from whose findings are extracted constitute a study's population [50]. Population is a group of individuals [51]. The intended audience consisted of Kenyan AI experts as the individuals.

2.3. Questionnaires

For the purposes of a census or analysis of statistics, a survey is a predetermined list of questions (or other prompts) given to respondents. It is challenging to ask questions in this field that do not need lengthy answers or evoke opposition from specific categories of targeted respondents (and hence biased results). It is not obvious what counts as “intelligence” or “progress,” or if mental prowess can even be reduced to a simple “more” or “less” numerical value [52].

3. RESULTS AND DISCUSSION

3.1. AI use motivation

A number of factors [53], [54] may influence a company's decision regarding the use of AI. Table 1 AI use and its motivation, lists the factors that were taken into account over the course of this investigation. These included the following: cost reduction, increased expertise and insight, new product development, competitiveness maintenance, and decision support. The survey set out to ascertain what people believe to be the most compelling case for utilizing AI. A majority of respondents (56%) expressed an interest in learning more [54].

Table 1. The factors examined in this study

| Motivation for the use of AI | Per cent |
|--|----------|
| ✓ Spend Less | ✓ 16 |
| ✓ Amplify Learning and Understanding by Making brand-new stuff | ✓ 56 |
| ✓ In order to maintain a competitive edge | ✓ 20 |
| ✓ Support in decision making | ✓ -8 |
| Total | 100 |

3.2. Degree level and AI implementation

The average usage of AI by the sampled firms is above 3. Proactive inventory management stands out as a rather extreme technology with a mean of 2.32, contributing to the study's overall mean of 3.205. Between 2.7 to 3.6 was the mean for the other seven technologies. As a result, respondents considered the usefulness of the predictive inventory system to be low. Mobile telecommunications providers in Kenya use AI tools to varying degrees, as shown by an aggregate mean score of 3.2 [55]. The data demonstrate that while many improvements have been adopted, they are not being fully utilized. According to Table 2 [55], this could be caused by an acute shortage of AI skills and knowledge, an organizational culture that does not support a thorough investigation of the technology, or problems with process flow integration.

Table 2. AI implementation degree

| The reach of AI-enabled technology | Mean | Standard deviation |
|---|-------|--------------------|
| Systematic approaches to voice-response recognition | 3.6 | 1.22475 |
| Text from speech and speech from text | 2.76 | 1.16476 |
| Analytical machinery | 3.4 | 1.35401 |
| Chatbots and other virtual personal assistants | 3.44 | 1.15758 |
| Consumer behaviour prediction | 3.16 | 0.8 |
| Strategic inventory planning | 2.32 | 1.40594 |
| Accurate online marketing campaigns | 3.4 | 1.19024 |
| The processing of natural language | 3.56 | 1.08321 |
| Average | 3.205 | 1.17256 |

3.3. Companies' tenure and use of AI

Table 3 clearly indicates that among the respondents, 52% had fewer than 5 years of experience, 40% had between 5 and 10 years, and 8% had between 10 and 15 years. According to the results, the respondents were very familiar with the company's marketing strategy [55]. Furthermore, they were very familiar with the application of technology based on artificial [55].

3.4. Education level

Seventy-six per cent of respondents as shown in Table 4 hold a bachelor's degree or above, while sixteen per cent hold master's degrees and eight per cent have just their high school diplomas. Over ninety-two per cent of respondents had a bachelor's degree or more, suggesting that they were well-versed in the effects that AI has on promotional strategies [55]. We recently polled Kenyans to gauge their opinions on the impact of AI in several fields, such as farming, teaching, medicine, the Matatu business, and the use of chatbots and digital assistants. Using a numeric scale from 1 to 5, with 5 being the best possible score. Figure 1 shows that chatbots have a 96% success rate, digital assistants have a 90% success rate, Matatus have a 46% success rate, healthcare has a 78% success rate, education has a 92% success rate, and agriculture has a 92% success rate.

Table 3. Years of experience in AI business

| Tenure | Per cent |
|-------------|----------|
| Below 5yrs | 52 |
| 5 to 10yrs | 40 |
| Above 15yrs | 8 |
| Total | 100 |

Table 4. Education level

| Level of education | Per cent |
|-----------------------------|----------|
| Certificate college diploma | 8 |
| Undergraduate | 76 |
| Master | 16 |
| Total | 100 |

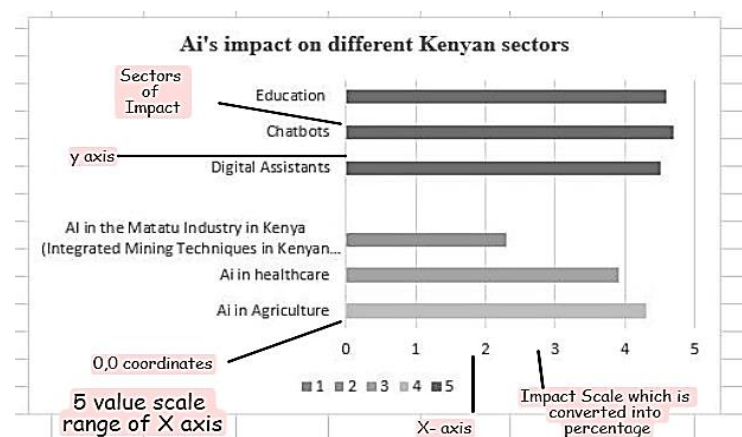


Figure 1. The influence of AI on Kenya's economy

3.5. AI's impact on different Kenyan sectors

Figure 1 depicts the influence of AI on Kenya's economy. Kenya's usage of AI has had a significant positive impact on the country's key industries, including agriculture, healthcare, and education. However, substantial adoption of AI has yet to occur in sectors such as manufacturing, elections, financial inclusion, and other public services sectors like land titling, dwellings, and transit in the United States. It's clear that the Kenyan government has to work with the private sector to build out the country's infrastructure and encourage the application of AI across all important sectors.

4. CONCLUSION

These results suggest that with the correct digital setting and facilities, data availability, education, and law, countries like Kenya in sub-Saharan Africa may adopt and apply AI. Simply said, AI may give solutions to many of the issues plaguing Kenya along with other sub-Saharan countries, and create new opportunities for economic growth. Investing in AI on a global scale is necessary to fully realize the benefits and opportunities it presents. The innovative and revolutionary potential of AI necessitates those governments craft policies that strike a similar balance between innovation and regulation.

ACKNOWLEDGEMENTS

Thank you very much to our department for financial support over the publishing of this paper.




REFERENCES

- [1] D. Fahrudy *et al.*, "Intelligent system for classification of student personality with naive bayes algorithm," *[SINTECH] (Science and Information Technology) Journal*, vol. 5, no. 1, pp. 1–9, Apr. 2022, doi: 10.31598/sintechjournal.v5i1.969.
- [2] "Artificial intelligence (AI) | definition, examples, types, applications, companies, and facts | Britannica," [Online]. Available: <https://www.britannica.com/technology/artificial-intelligence>.
- [3] "Artificial intelligence for Africa: An opportunity for growth, development and democratisation, access partnership, November 2018," [Online]. Available: <https://www.wathi.org/artificial-intelligence-for-africa-an-opportunity-for-growth-development-and-democratisation-access-partnership-november-2018/>.
- [4] R. Ndungi and S. Uyun, "A review of automated reasoning and its applications in the 21st century," *Indonesian Journal of Computer Science*, vol. 12, no. 2, pp. 483–491, Apr. 2023, doi: 10.33022/ijcs.v12i2.3175.
- [5] J. Shara, "The automation of mathematical reasoning," *Journal of Research in Applied Mathematics*, vol. 10, no. 2, pp. 122–131, 2021.
- [6] S. A. Wandansari, "Preliminary study of the integration of big data to answer the challenges of islamic education in the technological age," *International Journal on Informatics for Development (IJID)*, vol. 10, no. 2, pp. 122–131, May 2022, doi: 10.14421/ijid.2021.3319.
- [7] T. Kwanya, "Working with robots as colleagues: Kenyan perspectives of ethical concerns on possible integration of co-bots in workplaces," in *Social and Cultural Studies of Robots and [AI]*, Springer International Publishing, 2023, pp. 65–99.
- [8] B. J. Holland, *Handbook of research on technological advances of library and information science in industry 5.0*. [IGI] Global, 2022.
- [9] K. A. Pantserov, "Malicious use of artificial intelligence in sub-Saharan Africa: Challenges for pan-african cybersecurity," *Vestnik RUDN. International Relations*, vol. 22, no. 2, pp. 288–302, Jul. 2022, doi: 10.22363/2313-0660-2022-22-2-288-302.
- [10] A. Mustafid, M. M. Pamuji, and S. Helmiyah, "A comparative study of transfer learning and fine-tuning method on deep learning models for wayang dataset classification," *International Journal on Informatics for Development (IJID)*, vol. 9, no. 2, pp. 100–110, Dec. 2020, doi: 10.14421/ijid.2020.09207.
- [11] A. Aamodt, "A computational model of knowledge-intensive learning and problem solving," *Current Trends in Knowledge Acquisitions*, vol. 90, pp. 1–20, 1990.
- [12] A. Gadzala, "Coming to life: Artificial intelligence in Africa," *Atlantic Council - Africa Centre*. Brill, p. 12, 2018, doi: 10.1163/2210-7975_hrd-0128-20180017.
- [13] B. D. Okyere-Manu, *African values, ethics, and technology: Questions, issues, and approaches* - Google Books. [Online]. Available: <https://books.google.de/books?id=hUlsEAAAQBAJ&pg=PA72&lpg=PA72&dq=%5B8%5D+Artificial+Intelligence:+starting+the+policy+dialogue+in+Africa,+World+Wide+Web+Foundation.+https://webfoundation.org/research/artificial-intelligence-starting-the-policy-dialogue>
- [14] J. Kaur, R. Verma, N. R. Alharbe, A. Agrawal, and R. A. Khan, "Importance of fog computing in healthcare 4.0," in *Signals and Communication Technology*, Springer International Publishing, 2021, pp. 79–101.
- [15] "Artificial intelligence starting the policy dialogue in Africa," 2017, [Online]. Available: <https://webfoundation.org/research/artificial-intelligence-starting-the-policy-dialogue-in-africa/>.
- [16] A. Gwagwa, E. Kraemer-Mbula, N. Rizk, I. Rutenberg, and J. De Beer, "Artificial intelligence (AI) deployments in Africa: Benefits, challenges and policy dimensions," *The African Journal of Information and Communication*, no. 26, 2020, doi: 10.23962/10539/30361.
- [17] B. A. Shawar and E. Atwell, "Chatbots: Are they really useful?," *Journal for Language Technology and Computational Linguistics*, vol. 22, no. 1, pp. 29–49, Jul. 2007, doi: 10.21248/jlcl.22.2007.88.
- [18] İ. Dönmez, S. İdin, and S. Gülen, "Conducting academic research with the ai interface chatgpt: Challenges and opportunities," *Journal of STEAM Education*, vol. 6, no. 2, pp. 101–118, 2023, doi: 10.55290/steam.1263404.
- [19] A. J. C. Trappey, C. V. Trappey, M. H. Chao, and C. T. Wu, "VR-enabled engineering consultation chatbot for integrated and intelligent manufacturing services," *Journal of Industrial Information Integration*, vol. 26, p. 100331, Mar. 2022, doi: 10.1016/j.jii.2022.100331.
- [20] M. H. Chao, A. J. C. Trappey, and C. T. Wu, "Emerging technologies of natural language-enabled chatbots: A review and trend forecast using intelligent ontology extraction and patent analytics," *Complexity*, vol. 2021, pp. 1–26, May 2021, doi: 10.1155/2021/5511866.
- [21] R. Crutzen, G. J. Y. Peters, S. D. Portugal, E. M. Fisser, and J. J. Grolleman, "An artificially intelligent chat agent that answers adolescents' questions related to sex, drugs, and alcohol: An exploratory study," *Journal of Adolescent Health*, vol. 48, no. 5, pp. 514–519, May 2011, doi: 10.1016/j.jadohealth.2010.09.002.
- [22] H. S. Kim, Y. Cha, and N. Y. Kim, "Effects of ai chatbots on efl students' communication skills," *Korean Journal of English Language and Linguistics*, vol. 21, no. 10, pp. 712–734, 2021.
- [23] L. Fryer and R. Carpenter, "Emerging technologies: Bots as language learning tools," *Language Learning and Technology*, vol. 10, no. 3, pp. 8–14, 2006.
- [24] D. Zumstein and S. Hundertmark, "Chatbots – an interactive technology for personalized communication, transactions and services," *IADIS*, vol. 15, no. 1, pp. 96–109, 2017.
- [25] P. B. Brandtzaeg and A. Følstad, "Why people use chatbots," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, vol. 10673 LNCS, 2017, pp. 377–392.
- [26] C. V. Misischia, F. Poecze, and C. Strauss, "Chatbots in customer service: Their relevance and impact on service quality," *Procedia Computer Science*, vol. 201, no. C, pp. 421–428, 2022, doi: 10.1016/j.procs.2022.03.055.
- [27] H. B. Shih, "Designing a text-based AI scheduling assistant chatbot for a business environment: a case study of a mobile-based AI scheduling assistant app," *Master's thesis, University of Twente*, 2021.
- [28] M. Sugumar and S. Chandra, "Do I desire chatbots to be like humans? Exploring factors for adoption of chatbots for financial services," *Journal of International Technology and Information Management*, vol. 30, no. 3, pp. 38–77, Jan. 2021, doi: 10.58729/1941-6679.1501.
- [29] M. G. Gentiletti, G. Bourmaud, M. Fréjus, and F. Decortis, "Concevoir pour des activités instrumentées par des chatbots," *Activites*, no. 19–1, Apr. 2022, doi: 10.4000/activites.7428.
- [30] D. Coniam, "The linguistic accuracy of chatbots: Usability from an ESL perspective," *Text and Talk*, vol. 34, no. 5, pp. 545–567, Jan. 2014, doi: 10.1515/text-2014-0018.
- [31] "Press releases - UBA Kenya," [Online]. Available: <https://www.ubakenya.com/press-releases/>.
- [32] *Online analytical processing (OLAP) - azure architecture center | Microsoft Learn*. [Online]. Available: <https://learn.microsoft.com/en-us/azure/architecture/data-guide/relational-data/online-analytical-processing>
- [33] "AI chatbot platform Arifu is helping east African farmers learn finances and farming skills via texts | Synced," [Online]. Available: <https://syncedreview.com/2020/09/15/ai-chatbot-platform-arifu-is-helping-east-african-farmers-learn-finances-and-farming-skills-via-texts/>.




- [34] "East Africa: AI chatbot proves to be a useful teacher in farming and agronomy - allAfrica.com," 2020, [Online]. Available: <https://allafrica.com/stories/202009100564.html>.
- [35] "How can artificial intelligence-powered chatbots help policymakers? A roadmap for Kenya | IFPRI: International food policy research institute," 2023, [Online]. Available: <https://www.ifpri.org/blog/how-can-artificial-intelligence-powered-chatbots-help-policymakers-roadmap-kenya>.
- [36] G. Nyongesa, K. Omieno, and D. Otanga, "Artificial intelligence chatbot adoption framework for real-time customer care support in Kenya," *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, pp. 100–117, Nov. 2020, doi: 10.32628/cseit20667.
- [37] K. K. Nirala, N. K. Singh, and V. S. Purani, "A survey on providing customer and public administration based services using AI: chatbot," *Multimedia Tools and Applications*, vol. 81, no. 16, pp. 22215–22246, Jan. 2022, doi: 10.1007/s11042-021-11458-y.
- [38] K. Köhl and J. Gremmels, "A software tool for the input and management of phenotypic data using personal digital assistants and other mobile devices," *Plant Methods*, vol. 11, no. 1, Apr. 2015, doi: 10.1186/s13007-015-0069-3.
- [39] C. S. Cast *et al.*, "Connecting plant phenotyping and modelling communities: Lessons from science mapping and operational perspectives," *In Silico Plants*, vol. 4, no. 1, Jan. 2022, doi: 10.1093/insilicoplants/diac005.
- [40] M. C. T. Tai, "The impact of artificial intelligence on human society and bioethics," *Tzu Chi Medical Journal*, vol. 32, no. 4, pp. 339–343, 2020, doi: 10.4103/tcmj.tcmj_71_20.
- [41] O. M. Lehner, K. Ittonen, H. Silvola, E. Ström, and A. Wührleitner, "Artificial intelligence based decision-making in accounting and auditing: ethical challenges and normative thinking," *Accounting, Auditing and Accountability Journal*, vol. 35, no. 9, pp. 109–135, Jun. 2022, doi: 10.1108/AAAJ-09-2020-4934.
- [42] D. Chhillar and R. V. Aguilera, "An eye for artificial intelligence: Insights into the governance of artificial intelligence and vision for future research," *Business and Society*, vol. 61, no. 5, pp. 1197–1241, Apr. 2022, doi: 10.1177/00076503221080959.
- [43] F. Bruckner, "From auditing to auditing 4.0: the impact of artificial intelligence and blockchain technology on the business model of the big four auditing companies," pp. 1–113, 2022.
- [44] S. M. Al-Sayyed, S. F. Al-Aroud, and L. M. Zayed, "The effect of artificial intelligence technologies on audit evidence," *Accounting*, vol. 7, no. 2, pp. 281–288, 2021, doi: 10.5267/j.ac.2020.12.003.
- [45] F. Alaba and S. Ghanoum, "Integration of artificial intelligence in auditing: The effect on auditing process," 2020.
- [46] J. Mökander and L. Floridi, "Operationalising AI governance through ethics-based auditing: an industry case study," *AI and Ethics*, vol. 3, no. 2, pp. 451–468, May 2023, doi: 10.1007/s43681-022-00171-7.
- [47] A. Ade-Ibijola and C. Okonkwo, "Artificial intelligence in Africa: Emerging challenges," in *Social and Cultural Studies of Robots and [AI]*, Springer International Publishing, 2023, pp. 101–117.
- [48] "2019 Kenya population and housing census reports - CAHF | centre for affordable housing finance Africa," 2020, [Online]. Available: <https://housingfinanceafrica.org/documents/2019-kenya-population-and-housing-census-reports/>.
- [49] KNBS, "Kenya population and housing census volume 1: Population by county and sub-county," vol. 1, 2019.
- [50] A. C. Thoo, M. B. P. Lim, H. T. Huam, and Z. Sulaiman, "Increasing destination loyalty of international students towards Malaysian higher educational institutions," *International Journal of Evaluation and Research in Education*, vol. 11, no. 1, pp. 31–41, Mar. 2022, doi: 10.11591/ijere.v11i1.21619.
- [51] D. A. Kindig and G. Stoddart, "What is population health?," *American Journal of Public Health*, vol. 93, no. 3, pp. 380–383, Mar. 2003, doi: 10.2105/AJPH.93.3.380.
- [52] V. C. Müller and N. Bostrom, *Fundamental issues of artificial intelligence*. Springer International Publishing, 2016.
- [53] C. Pitt, J. Paschen, J. Kietzmann, L. F. Pitt, and E. Pala, "Artificial intelligence, marketing, and the history of technology: Kranzberg's laws as a conceptual lens," *Australasian Marketing Journal*, vol. 31, no. 1, pp. 81–89, Sep. 2023, doi: 10.1177/18393349211044175.
- [54] S. L. Wamba-Taguimdje, S. F. Wamba, J. R. K. Kamdjoug, and C. E. T. Wanko, "Influence of artificial intelligence (AI) on firm performance: the business value of AI-based transformation projects," *Business Process Management Journal*, vol. 26, no. 7, pp. 1893–1924, May 2020, doi: 10.1108/BPMJ-10-2019-0411.
- [55] I. F. Githui, "Influence of artificial intelligence on marketing strategy among mobile telephony operators in Kenya," vol. 1, 2019.

BIOGRAPHIES OF AUTHORS



Rebecca Ndungi    She was born and raised in Nairobi, Kenya. She has a seasoned work experience in the IT industry. She obtained her masters degree from Informatics Department, UIN Sunan Kalijaga Yogyakarta, Indonesia in 2023 and has a research interest in machine learning. Additionally, she has a bachelors degree of Business in Information Technology from St Pauls University Limuru, Kenya. She enjoys reading and doing more research in IT sector and primarily in Artificial Intelligence and Machine learning. She can contact me via email at: rebeccahndungi94@gmail.com.



Dr. Maria Ulfah Siregar    is a lecturer in the Informatics Department, Faculty of Science and Technology, UIN Sunan Kalijaga Yogyakarta, Indonesia. She received her bachelor's degree from Institut Teknologi Sepuluh November (ITS) Surabaya, Indonesia, majoring in Informatics in 2002. Then, she obtained her master's degree from Universiti Kebangsaan Malaysia (UKM), majoring in Computer Science in 2007. Next, she got a doctoral degree in Computer Science in 2017 from the University of Sheffield. She can contact me via email at: maria.siregar@uin-suka.ac.id.